Bol. Inst. Esp. Oceanogr. 16 (1-4). 2000: 29-36

BOLETÍN. INSTITUTO ESPAÑOL DE OCEANOGRAFÍA
ISSN: 0074-0195

Predominance of exotic and introduced species among sturgeons captured from the Baltic and North Seas and their watersheds, 1981-1999

G. M. Arndt[1], *J. Gessner*[1], *E. Anders*[2], *S. Spratte*[3], *J. Filipiak*[4], *L. Debus*[5] *and K. Skora*[6]

[1] Society to Save the Sturgeon *Acipenser sturio* L. e.V., An der Jägerbäk 2, D-18069 Rostock, Germany. E-mail: fischum@excite.com
[2] Landesforschungsanstalt für Landwirtschaft und Fischerei des Landes Mecklenburg-Vorpommern, Südstrasse 10, D-18375 Born/Darss, Germany
[3] Landessportfischereiverband Schleswig-Holstein e.V., Papenkamp 52, D-24114 Kiel, Germany
[4] Szczecin University of Agriculture, Department of Fishery Management in the Inland Waters, K. Krolewicza 4, 71-660 Szczecin, Poland
[5] Department of Zoology, Institute of Biology, University of Rostock, Universitätsplatz 2-5, D-18023 Rostock, Germany
[6] Hel Marine Station, University of Gdansk, Morska 9, 84150 Hel, Poland

Received September 1999. Accepted June 2000.

ABSTRACT

Sturgeon catches (n = 256) from 1981-1999 reported mainly by commercial fishermen and anglers in German, Polish, and Dutch coastal waters and tributaries were analysed. During the study period, 20 % of catches were reported from coastal waters and 65 % from rivers and estuaries of large river systems, including the Odra, Elbe, Rhine and Weser. The data indicate that, from 1981-1993, there was a major decline in the Atlantic sturgeon *Acipenser sturio* L., 1758, and an increase in the total catches of non-indigenous sturgeon species. The Siberian sturgeon *Acipenser baerii* Brandt, 1869, the Russian sturgeon *Acipenser gueldenstaedtii* Brandt & Ratzeberg, 1833, and various hybrids dominated. Occasional catches of the white sturgeon *Acipenser transmontanus* Richardson, 1836 and the sterlet *Acipenser ruthenus* L., 1758 were also reported. During the study period, significant changes in species composition and distribution of catches were observed. The predominance of non-indigenous sturgeon species is a result of the increasingly intensive sturgeon aquaculture activities in Germany, Poland, and the Netherlands. The most frequently reared species now dominate the catches. In addition to these escapees from fish farms, several intentional releases of sturgeons were reported. The results show that introduced exotic sturgeon species may thrive under certain natural conditions. Therefore, they may interfere with restoration efforts for the native *A. sturio*, competing for habitat and introducing diseases and hybridization.

Key words: *Acipenser,* aquaculture, introductions, distribution, conservation.

RESUMEN

Predominio de especies exóticas introducidas entre los esturiones capturados en el mar Báltico, en el Mar del Norte y en sus cuencas, 1981-1999

Se analizaron las capturas de esturiones (n = 256) entre 1981 y 1999 proporcionadas principalmente por pescadores profesionales y deportivos en las costas alemanas, polacas y holandesas, y en los sistemas fluviales que desembocan en ellas. En el periodo de estudio, el 20 % de las capturas correspondió a aguas litorales y el 65 % a ríos y estuarios de los grandes sistemas fluviales, incluidos los ríos Oder, Elba, Rin y Weser. Los datos

indican que entre 1981 y 1993 tuvo lugar el mayor declive del esturión atlántico Acipenser sturio *L., 1758 y un incremento en las capturas totales de las especies alóctonas de esturiones. Predominaron las capturas de esturión siberiano* Acipenser baerii *Brandt, 1869, esturión ruso* Acipenser gueldenstaedtii *Brandt & Ratzeberg, 1833 y varios híbridos. También se registraron capturas ocasionales de esturión blanco* Acipenser transmontanus *Richardson, 1836 y esterlete* Acipenser ruthenus *L., 1758. En el periodo de estudio se observaron cambios significativos en la composición de especies y en la distribución de las capturas. El predominio de las especies alóctonas de esturiones es el resultado de las crecientes actividades en la acuicultura intensiva de esturión en Alemania, Polonia y Países Bajos. Las especies cultivadas más frecuentemente dominan ahora las capturas. Además de estas fugas de las piscifactorías, se han registrado varias sueltas intencionadas. Los resultados muestran que las especies de esturiones exóticas introducidas pueden prosperar en ciertas condiciones naturales. Por esta razón, pueden interferir en los esfuerzos de restauración de la especie autóctona* A. sturio*, compitiendo por el hábitat e introduciendo enfermedades e hibridación.*

Palabras clave: Acipenser, *acuicultura, introducciones, distribución, conservación.*

INTRODUCTION

The onset of the 20th century saw a major decline in the Atlantic sturgeon *Acipenser sturio* L., 1758 throughout its previous range due to anthropogenic impact (Mohr, 1952; Holčík *et al.*, 1989; Birstein, 1999). Since the 1950s, the occurrence of *A. sturio* in German, Polish, and Dutch coastal waters and tributaries has been limited to infrequent and incidental captures of single individuals (Spratte and Rosenthal, 1996).

Programmes to conserve and protect the Atlantic sturgeon are confronted not only with the scarcity or even absence of individuals, but also with the paucity of useful data on the species's biology and ecology. Moreover, the current aquaculture activities and the increasing importance of sturgeons in the pet trade since the early 1990s have contributed to a drastic increase in exotic sturgeon species in natural waters due to accidental or intentional releases by private persons or organizations. To assess this development, in 1994 the Society to Save the Sturgeon started monitoring these events (Arndt and Anders, 1997). The Society gathers data on the distribution of sturgeons, species composition of the catch, and catching techniques, in order to provide a sound database. The campaign also safeguards occasional catches of *A. sturio* in the study area, to be included in restoration attempts. The present study analyses the data collected by the Society on the 1981-1999 sturgeon catch.

MATERIALS AND METHODS

Data collection

Since the early 1990s, several research institutions have used questionnaires to uncover sturgeon catches. In 1994, a campaign was launched to obtain the collaboration of local fishermen and fisheries administrators in obtaining catch data and live specimens, featuring press releases, the distribution of information leaflets, and personal contacts. Data were collected by scientists in the respective regions, who attempted to identify sturgeon species. In instances when live fish were unavailable, fishermen were asked to provide photographs of dorsal, ventral, and side views of the whole fish. These specimens could only be confidently identified in a limited number of cases, since they were rarely photographed; in others, although fish were available, identification was not possible due to hybridization. When possible, total length and wet weight were taken.

Data analysis

Data analysis was performed after dividing the catches into two periods, period I (1981-1993) and period II (1994-1999). The cut-off between them was 1993, when the last *A. sturio* individuals were caught along the Dutch and German coasts and off Heligoland Island (Spratte and Rosenthal, 1996). To determine the temporal and spatial differences in the catches and species composition, a chi-square test (after Renner, 1981) was used.

RESULTS

A total of 256 sturgeons of various species and hybrids had been reported in the area since 1981. Differences in frequencies of catches, their distribution, and species composition were detected be-

tween periods I and II (figure 1, table I). With the exception of *A. sturio,* total sturgeon catches have increased in the study area during the 1990s. The total catches during the two periods differed significantly (n = 256; $\chi^2 = 5.441$; d.f. = 2; $p > 0.05$). Peak catches of exotic sturgeons were recorded between 1994-1996 (figure 1). The catches originated from the entire observation area (figure 2). Most of the catches (85 %) were reported from coastal waters and large rivers, such as the Odra, Elbe, Weser, and Rhine. The remaining 15 % originated from canals, lakes, and other water bodies.

The origin of catches varied between the North Sea and the Baltic Sea areas. In 1981-1993, there was a significant difference between both areas in the number of recorded catches from coastal and estuary regions (n = 57; $\chi^2 = 7.13$; d.f. = 1; $p < 0.01$). In the North Sea area, similar levels of catches were reported in rivers/estuaries and coastal waters. In the Baltic Sea, catches in rivers/estuaries far exceeded those from coastal waters. However, the situation was reversed during the second period, 1994-1999 (n = 162; $\chi^2 = 8.20$; d.f. = 1; $p < 0.01$).

Species composition throughout the range revealed significant changes between the two periods (n = 256; $\chi^2 = 49.23$; d.f. = 4; $p < 0.001$). Until 1993, *A. sturio* comprised 21 % of the catches in natural waters. The exotic species *Acipenser baerii* Brandt, 1869 and *Acipenser gueldenstaedtii* Brandt & Ratzeberg, 1833 were observed in similar proportions in the

Table I. Changes in total catch, species composition, and distribution of sturgeon catches in Polish, German, and Dutch coastal and inland waters, 1981-1999

	The North and Baltic Seas and tributaries		The North Sea and tributaries		The Baltic Sea and tributaries	
	1981-1993	1994-1999	1981-1993	1994-1999	1981-1993	1994-1999
Total catch (n)	62	194	42	85	20	109
A. sturio	16	2	16	2	0	0
A. baerii	11	56	11	23	0	33
A. gueldenstaedtii	8	11	1	0	7	11
A. ruthenus	1	0	1	0	0	0
A. transmontanus	0	3	0	3	0	0
Hybrids	2	12	2	9	0	3
Non-identified	24	110	11	48	13	62
Coastal waters	18	34	17	1	1	33
A. sturio	13	0	13	0	0	0
A. baerii	0	8	0	0	0	8
A. gueldenstaedtii	2	4	1	0	1	4
A. ruthenus	0	0	0	0	0	0
A. transmontanus	0	0	0	0	0	0
Hybrids	2	0	2	0	0	0
Non-identified	1	22	1	1	0	21
Rivers and estuaries	39	127	21	80	18	47
A. sturio	3	0	3	0	0	0
A. baerii	10	43	10	22	0	21
A. gueldenstaedtii	6	3	0	0	6	3
A. ruthenus	1	0	1	0	0	0
A. transmontanus	0	3	0	3	0	0
Hybrids	0	9	0	8	0	1
Non-identified	19	69	7	47	12	22
Other (lakes, canals)	5	33	4	4	1	29
A. sturio	0	2	0	2	0	0
A. baerii	1	5	1	1	0	4
A. gueldenstaedtii	0	4	0	0	0	4
A. ruthenus	0	0	0	0	0	0
A. transmontanus	0	0	0	0	0	0
Hybrids	0	3	0	1	0	2
Non-identified	4	19	3	0	1	19

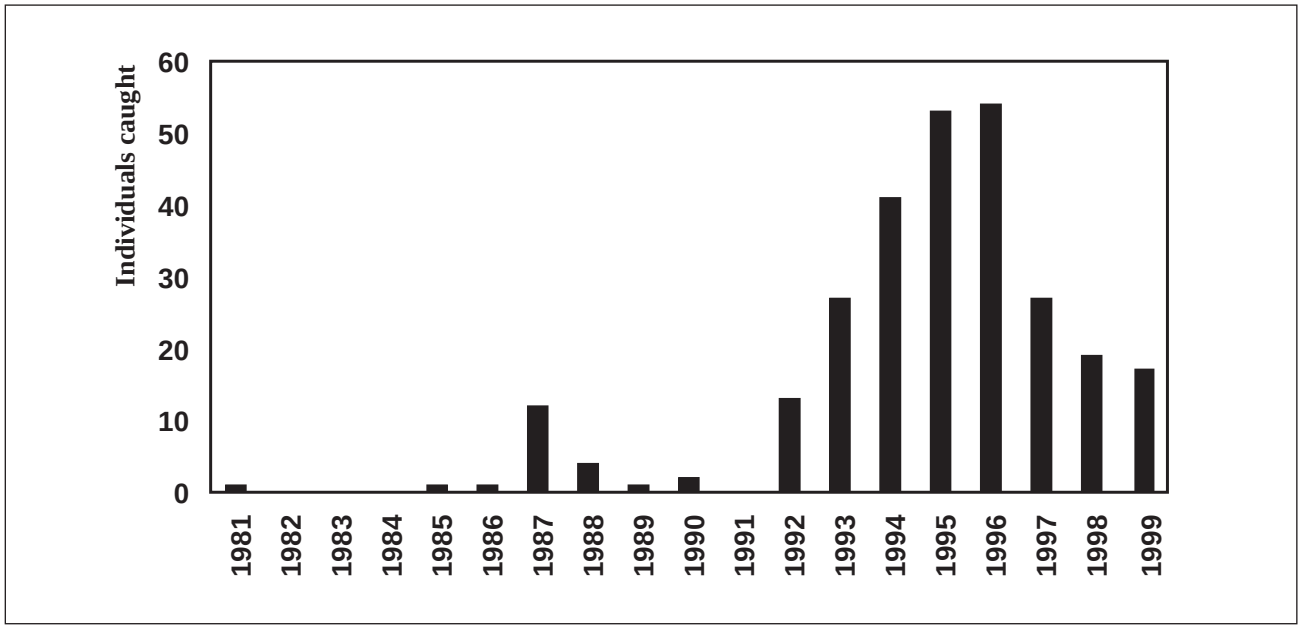

Figure 1. Development of sturgeon catches in Polish, German, and Dutch coastal and inland waters since 1981

catch during period I. In period II, *A. baerii* became dominant. Also, a significant increase was observed in the number of unidentified sturgeon species.

Species composition within specific regions also differed significantly between the two periods. In coastal waters ($n = 52$; $\chi^2 = 29.61$; d.f. = 4; $p < 0.001$), the main change was the drop in *A. sturio*. In rivers/estuaries, the main changes ($n = 166$; $\chi^2 = 18.81$; d.f. = 2; $p < 0.001$) were caused by the increase in *A. baerii* and unidentified species. In the North Sea and its tributaries, the change in species composition between the two periods was significant ($n = 127$; $\chi^2 = 35.69$; d.f. = 4; $p < 0.001$), whereas in the Baltic Sea and its tributaries, this was not the case ($n = 129$; $\chi^2 = 2.37$; d.f. = 2; $p > 0.05$).

When comparing the species composition of catches from the North Sea area to those from the Baltic Sea area for period I, significant differences ($n = 62$; $\chi^2 = 11.25$; d.f. = 2; $p < 0.01$) were observed due to the differences in catches in rivers/estuaries ($n = 39$; $\chi^2 = 9.36$; d.f. = 2; $p < 0.01$). During the second period, no significant differences were found between the two areas.

An assessment of catch by gear types was limited to period II. Earlier data had indicated that the majority of *A. sturio* were caught with active gear (i.e. trawls). For the second period, anglers (53 %) were the main source of catch reports, predominantly from rivers and estuaries. Set nets (37 %) with mesh sizes from 50-120 mm, mainly used in depths

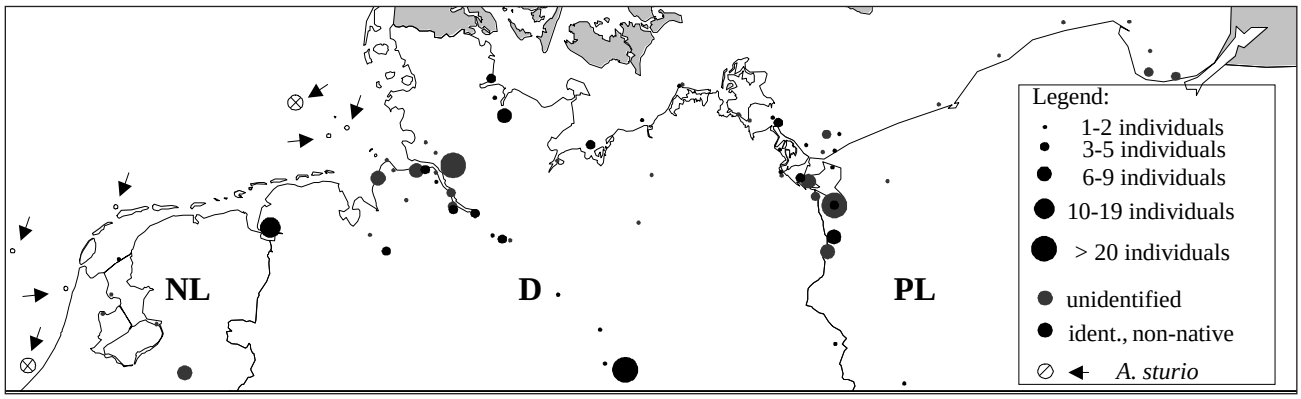

Figure 2. Distribution of sturgeon catches in Polish, German, and Dutch coastal and inland waters, 1981-1999 (modified after Gessner *et al.*, 1999)

from 2-18 m in coastal waters and estuaries, captured the second largest number of reported fish. Additional sources were water abstraction devices from nuclear power plants or factories (4 %), stow nets (4 %), fish traps (1 %), and miscellaneous others (1 %).

Also, we tried to estimate sturgeons' migration potential. The prerequisite was to include only those fish that could derive from a single mass release in a region where interference with other releases might be negligible. Accidental releases from aquaculture facilities occurred in a Polish tributary of the Odra River in 1992 and 1995, when thousands of *A. gueldenstadtii* and *A. baerii* escaped from net pens. The fish remained in the Szczecin lagoon area until they reached approximately 50 cm in length. Sturgeon specimens more than 70 cm in length were observed up to 400 km west in the Bights of Wismar, Lübeck, and Kiel. Their origin is unknown.

DISCUSSION

A. sturio was once a common fish, not only in German rivers and coastal waters, but in all major river systems of Europe, until the beginning of the 20th century (Holčík *et al.*, 1989). Since the 1950s, the species has been considered highly endangered throughout its previous range (Holčík *et al.*, 1989; Bless, Lelek and Waterstraat, 1994; Arndt, 1999).

During the study period, the occurrence of *A. sturio* in German and neighbouring waters was restricted to rare, incidental captures. The last individuals in the area were caught in Dutch and German coastal waters during the period 1981-1993 (Spratte and Rosenthal, 1996; Debus, 1997; Gessner *et al.*, 1999; table II). Contrariwise, the number of catches of non-indigenous sturgeon species increased during the 1990s (table I). This is especially alarming, because it is highly probable that only a minority of these total catches has been reported, as witnessed

Table II. Records of *A. sturio* in Polish, German, and Dutch coastal and inland waters since 1981. (1) NL: Netherlands

No.	Date	Location[1]	Length (cm)	Weight (kg)	Remarks	Author
1	Summer 1985	North Sea near Heligoland Island	140	12.80	–	Anon., 1985
2-5	Late 1980s	German Bight	–	–	Tagged	Steinert, 1990a, b
6	01 June 1989	German Bight	–	–		Lamp, 1989, 1990
7	08 January 1992	Merwede, the Rhine River delta, NL	70	–	–	Volz and De Groot, 1992
8	1992	Scheveningen, NL	98	–	–	Timmermanns and Melchers, 1994
9	25 February 1992	North Sea, Terschelling-Island, NL	135	8.50	–	Stolzenburg, 1992
10	04 May 1992	North Sea, 15 miles west of Ijmuiden, NL	125	–	–	Volz and De Groot, 1992
11	07 February 1993	Noordzeekanaal, Amdhaven, NL	61	–	–	Timmermanns and Melchers, 1994
12	May 1993	3 km off Kijkduin, NL	106	9.00	–	Timmermanns and Melchers, 1994
13	02 June 1993	Rede van Vlissingen, NL	135	8.90	–	Timmermanns and Melchers, 1994
14	12 June 1993	Noordzeekanaal zijkanal B, NL	51	–	–	Timmermanns and Melchers, 1994
15	01 September 1993	Oosten Aalsmeer, NL	35	–	–	Timmermanns and Melchers, 1994
16	26 October 1993	North Sea, south of Heligoland Island	285	142.50	–	Anon., 1993a, b
17-18	April 1996	Pond near Lake Constance	100	–	–	Originating from the Elbe River in the early 1980s

Table III. Natural range of the exotic sturgeon species caught in Polish, German, and Dutch coastal and inland waters, 1981-1993 (after Hochleithner, 1996)

Species	Natural range
A. baerii	Siberia: almost all Siberian rivers from the Ob to the Kolyma and adjacent coastal waters; Lake Baikal
A. gueldenstaedtii	Black, Azov, and Caspian Seas and their tributaries
A. ruthenus	fresh waters: tributaries of the Black, Azov, Caspian, White, and Cara Seas
A. transmontanus	Pacific coast of North America, from Alaska to California and major rivers

in several tagging experiments (Netzel, 1990; Bjordal and Skar, 1992). In addition, total captures most likely reflect only a small percentage of the population in different watersheds.

The registered catches peaked between 1994 and 1996 (figure 1). This could reflect either the increased harvest or increased reporting by fishermen, as a result of by the Society to Save the Sturgeon's public awareness campaign. The drop in reported catches from 1997 to 1999 may be attributed to the fact that fishermen became used to continuous catches and therefore lost interest in sturgeons, so that their co-operative efforts with the Society slackened.

The occurrence of exotic sturgeons is closely linked to increasingly intensive sturgeon aquaculture activities in Germany and neighbouring countries (Steffens, Jähnichen and Fredrich, 1990; Rosenthal and Gessner 1992; Arndt and Mieske, 1992, 1994; Gessner *et al.*, 1999). Catch data have revealed a rise in the number of cultured species during recent years. There were reports of sturgeons escaping from aquaculture facilities in the estuary of the Odra River in 1992 and 1995 (*A. gueldenstaedtii* and *A. baerii*), and from the Elbe River catchment area near Leipzig in 1995 (*A. baerii* × *A. ruthenus*). Apart from these escapees, additional releases by aquarists and/or anglers may have contributed to escapements, as confirmed for *A. baerii* in 1986 in the Ems River (Anon., 1987).

Non-indigenous sturgeon introductions pose a threat to ongoing or planned activities for the re-establishment of *A. sturio* within its native range (table III). A previous example of such a threat was the introduction of the Caspian beluga *Huso huso* (L., 1758) into the Sea of Azov, which led to the almost complete extinction of the endemic form (Pavlov *et al.*, 1994; Debus, 1997). Furthermore, the transfer of parasites and diseases must be considered another serious threat (Rosenthal and Gessner, 1990). Thus, a transfer of the stellate sturgeon *Acipenser stellatus* Pallas, 1771 from the Caspian into the Aral Sea resulted in a significant loss in the local population of the ship sturgeon *Acipenser nudiventris* Lovetzky, 1828 caused by the introduction of the nematode *Nitzschia sturionis* (Pavlov *et al.*, 1994; Zholdasova, 1997). Additionally, the potential interaction of non-indigenous species might interfere with natural reproduction, leading to hybridization (see Holčík, 1989 for a review). It remains unproven whether any of the introduced fish, including those introduced into the Baltic Sea during the late 1950s (Simanovskaya and Kuljusina, 1967; Otterlind, 1970; Kairov, 1975), reached sexual maturity, but the potential threat is real. Considering the fact that sturgeons tend to hybridize freely (Holčík *et al.*, 1989; Birstein, Hanner and DeSalle, 1997), there is sound reason to expect the introgression of exotic genotypes with native *A. sturio* gene pools.

Despite the fact that this development is considered detrimental, the introduction of exotic sturgeons offers the potential to investigate their migration patterns and vital rates. Such information might be beneficial when applied to re-establishment programmes. The data gathered since the escape of sturgeons from fish farms in the Odra River tributaries show that, in general, sturgeons still find niches in environments that have been drastically altered by human activities. This leads to the conclusion that the possibility of sturgeon survival cannot be neglected, as it was previously (Nellen, 1992).

In conclusion, we consider the following efforts are needed to continue monitoring the sturgeon situation in the Baltic and North Sea areas. Further research is necessary to determine the levels of incidental harvest and mortality of sturgeons in the areas under discussion. Fishery techniques should be improved to reduce sturgeon by-catch. Reports of captured sturgeons resulting from the survey carried out by the Society to Save the Sturgeon have already drawn public attention to conservation measures. Further information campaigns to increase public awareness are urgently needed to prevent anglers and aquarists from releasing fish into the rivers in naive attempts to support sturgeon stocks. Stricter safeguarding is required to

avoid escapes from fish farms. Strict fish health regulations for imports, through the adoption of the ICES/EIFAC Code of Practice (Anon., 1995) are required. Improved control of the pet trade in sturgeons to avoid "littering" of the environment by exotic sturgeon species should also be considered.

ACKNOWLEDGEMENTS

The work described was partially supported by the E & E Programme of the Federal Agency for Nature Conservation, Az. Z1.2-892 11-4/96. The authors are especially grateful for the support of the fishermen who kept reporting their catches and provided the fish for the data collection despite of the effort.

REFERENCES

Anon. 1985. Holländer fingen Nordsee-Stör. *Fisch & Fang*: p. 26.

Anon. 1987. Wiedereinbürgerung des Stör. *Sportfischer in Weser-Ems* 36(1): 5-6.

Anon. 1993a. Der Gemeine Stör und der Artenschutz. *Frankfurter Allgemeine Zeitung* 05-11-1993: p. 4.

Anon. 1993b. Stör-Fall auf dem Fischmarkt. *Hamburger Morgenpost* 30.11.1993: p. 12.

Anon. 1995. Precautionary approach to fisheries. Part 1: Guidelines on the precautionary approach to capture fisheries and species introductions. *FAO Fisheries Technical Paper* 350 Part 1: 52 pp. Rome.

Arndt, G. M. 1999. Der Stör *Acipenser sturio* L.. Vergangenheit und Perspektive im Nord- und Ostseeraum. *Schutzgemeinschaft Deutsche Nordseeküste e.V. SDN-Magazin* 1999: 37-42.

Arndt, G. M. and E. Anders. 1997. Der Stör (*Acipenser sturio* L.) und seine Wiedereinbürgerung in Mecklenburg-Vorpommern und Deutschland. *Fischerei in Mecklenburg-Vorpommern* 4 (97): 14-19.

Arndt, G. M. and C. Mieske. 1992. Wiederbelebung des Bestandes des nahezu ausgestorbenen Baltischen Störs (*Acipenser sturio* L.) durch Nachzucht und Besatzmaßnahmen. *Wissenschaftliche Schriftenreihe Fisch & Umwelt M.-V. e.V.*: 42-68.

Arndt, G. M. and C. Mieske. 1994. Weitere Untersuchungen zur Aufzucht und Haltung von Stören/Störhybriden. *Wissenschaftliche Schriftenreihe Fisch & Umwelt M.-V. e.V.*: 42-59.

Birstein, V. J. 1999. Effect of ecosystem degradation on anadromous sturgeons. In: *Proceedings of the CMS Symposium on Animal Migration* (April 13, 1997. Gland, Switzerland). *CMS Technical Series* 2: 19-37. Bonn/The Hague.

Birstein, V. J., R. Hanner and R. DeSalle. 1997. Phylogeny of the Acipenseriformes: cytogenetic and molecular approaches. In: *Sturgeon Biodiversity and Conservation*. V. J. Birstein, J. R. Waldman and W. E. Bemis (eds.): 127-155. Kluwer Academic Publishing. Dordrecht, Netherlands.

Bjordal, A. and A. B. Skar. 1992. Tagging of saithe (*Pollachius virens* L.) at a Norwegian fish farm: preliminary results on migration. *ICES C.M.* 1992/G:35: 1-7.

Bless, R., A. Lelek and A. Waterstraat. 1994. Rote Liste und Artenverzeichnis der in Deutschland in Binnengewässern vorkommenden Rundmäuler und Fische (Cyclostomata & Pisces). In: *Rote Liste der gefährdeten Wirbeltiere in Deutschland (Schriftenreihe für Landschaftspflege und Naturschutz)*. E. Nowack, J. Blab and R. Bless (eds.) 42: 137-156.

Debus, L. 1997. Sturgeons of Europe and causes for their decline. In: *Sturgeon Stocks and Caviar Trade Workshop*. V. J. Birstein, A. Bauer and A. Kaiser-Pohlmann (eds.): 55-67. IUCN. Gland, Switzerland and Cambridge, UK.

Gessner, J., L. Debus, J. Filipiak, S. Spratte, K. E. Skora and G. M. Arndt. 1999. Development of sturgeon catches in German and adjacent waters since 1980. *J. Appl. Ichthyol.* 15: 136-141.

Hochleithner, M. 1996. *Störe-Verbreitung, Lebensweise, Aquakultur*. Östereichischer Agrarverlag. Klosterneuburg: 202 pp.

Holčík, J. (ed.). 1989. *The Freshwater Fishes of Europe, vol. 1, pt. II. General Introduction to Fishes, Acipenseriformes*. AULA-Verlag. Wiesbaden: 469 pp.

Holčík, J., R. Kinzelbach, L. I. Sokolov and V. P. Vasil'ev. 1989. *Acipenser sturio* Linnaeus, 1758. In: *The Freshwater Fishes of Europe, vol. 1, part II. General Introduction to Fishes, Acipenseriformes*. J. Holčík (ed.): 364-394. AULA-Verlag. Wiesbaden.

Kairov, E. A. 1975. Experiments on the introduction of sturgeons in the Riga Gulf. *Rybnoe Khozyaistvo* 1975 (6): 10-11 (in Russian).

Lamp, F. 1989. Französische Bemühungen um Erhaltung des Störbestandes sollten unterstützt werden. *Inf. Fischwirtsch.* 36 (4): 161-162.

Lamp, F. 1990. Helft bei der Stör-Rettung. *Fischerblatt* 38 (1): 5-7.

Mohr, E. 1952. *Der Stör. Die neue Brehm-Bücherei*. 84. Akademie Verlagsgesellschaft Geest und Portig K. G. Leipzig: 66 pp.

Nellen, W. 1992. Fische und Fischerei in der Elbe. In: *Die Unterelbe-natürlicher Zustand und Veränderungen durch den Menschen*. H. Kausch (ed.) 19: 205-223. Berichte Zentrum für Meeres- und Klimaforschg. Univ. Hamburg.

Netzel, J. 1990. Cod migration in the souther Baltic. *ICES C.M.* 19: 1-9.

Otterlind, G. 1970. Swedish records of sturgeons (*Acipenser gueldenstaedtii* and *Acipenser baerii*) introduced into the Baltic by the USSR. *ICES C.M.* 1970 (E): 1-13.

Pavlov, D. S., K. Savvaitova, L. I. Sokolov and S. S. Alekseev. 1994. *Rare and Endangered animals: Fishes*. Vysshava Shkola. Moscow: 334 pp. (in Russian).

Rosenthal, H. and J. Gessner. 1990. Ist die Einfuhr von *Acipenser transmontanus* ohne Risiko? *Fischer und Teichwirt* 41 (11): 295-296.

Rosenthal, H. and J. Gessner. 1992. Status and prospects of sturgeon farming in Europe. In: *Efficiency in Aquaculture*

Production, Production Trends, Markets, Products, and Regulations. Proc. 5th Int. Conf. on Aquafarming "Acquacoltura '90" (October 12-13, 1990. Verona, Italy). H. Rosenthal and E. Grimaldi (eds.): 143-192.

Simanovskaya, L. and E. Kuljusina. 1967. The distribution of the Russian sturgeon in the Baltic Sea. *Rybnoe Khozyaistvo* 43: 8-17 (in Russian).

Spratte, S. and H. Rosenthal. 1996. Meldungen über Störfänge im Einzugsbereich der deutschen Nordseeküste (1981-1985). *Fischer und Teichwirt* 47 (3): 78-82.

Steffens, W., H. Jähnichen and F. Fredrich. 1990. Possibilities of sturgeon culture in Central Europe. *Aquaculture* 89: 101-122.

Steinert, H. 1990a. Bald wieder Störe in der Eider? Markierte Fische aus der Gironde gefangen. *Frankfurter Allgemeine Zeitung* 29-11-1990.

Steinert, H. 1990b. Eine Zukunft für die Fischriesen in der Eider? *Dithmarscher Rundschau* 16-10-1990.

Stolzenburg, H. 1992. Störe in der Nordsee. *Fisch & Fang* 11: 121-122.

Timmermanns, G. and M. Melchers. 1994. De steur in Nederland. *Natura* 7: 155-158.

Volz, J. and S.J. De Groot. 1992. Erster Nachweis des Störs (*Acipenser sturio*) im niederländischen Rhein seit 40 Jahren. *Fischökologie* 6: 3-6.

Zholdasova, I. 1997. Sturgeons and the Aral Sea ecological catastrophe. In: *Sturgeon Biodiversity and Conservation*. V. J. Birstein, J. R. Waldman and W. E. Bemis (eds.): 373-380. Kluwer Academic Publishing. Dordrecht, Netherlands.